A C T A T H E R I O L O G I C A

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Intake and Digestibility of Natural Feeds by Roe-deer*

[With 2 Tables & 3 Figs.]

The investigations of the intake and digestibility of natural feeds in the year cycle were carried out by the balance method on 3 individuals of roe-deer, *Capreolus capreolus*. Season-depending changes in the chemical composition of natural food were ascertained: total protein amounted to 8—9% in winter and to 16—19% in summer, while the fibre content was the highest in winter feeds (30—47%). The food intake ranged from 350 g of dry matter in winter to 600 g d.m. in summer, these values corresponding to 1300—2800 kcal/day. The digestibility of dry matter varied with season and chemical composition of food, being the highest in May (87%) and the lowest in January (34%). A clear relationship was found to exist between the digestibility and fibre content and food intake. The intake of digestible energy by roe-deer in winter ranged from 70 to 102 kcal/kg$^{0.75}$ day, while the mean intake in the remaining seasons amounted to 197 ± 53 kcal/kg$^{0.75}$ day.

I. INTRODUCTION

The problem of food carrying capacity of forests for herbivorous animals has recently focused attention of the forest service and hunters. On account of disturbances caused by man in the natural environment a considerable increase of damages caused by the game in the agriculture and forest production is observed. Hence the investigations become essential to establish the optimum density of these animals in order to have the highest yield of the animal biomass and the lowest damages caused to forests. For the full understanding of the importance of cervides in an ecosystem there are needed data on the food available (Dzięciołowski, 1970; Dzięciołowski, 1970a; Bobek, Weiner & Zieliński, 1972), as well as studies on the requirement and utilization of natural feeds in the year cycle by these animals.

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Table 1. Chemical composition, caloric value and protein ratio of foods.

No of. experi-ment	Food	Composition of food, %*	Water %	Ash %	Organic mat-ter (%)	Crude protein %	Ether extr. %	Crude fiber, %	N-free extr, %	Caloric value	Pro-tein ratio
1.	*Quercus* sp.	55.1									
	Corylus avellana	18.8	45.4	3.01	96.99	8.07	2.36	40.70	46.49	4.864	1 : 11.4
	Fagus silvatica	26.1									
2.	*Quercus* sp.	32.1									
	Fagus silvatica	35.0	44.9	3.02	96.98	7.92	3.76	29.54	55.76	5.128	1 : 11.8
	Betula sp.	32.9									
3.	*Quercus* sp.	35.3									
	Fagus silvatica	21.5	53,3	3.24	96.76	9.38	3.03	31.27	53.08	4.939	1 : 9.7
	Salix sp.	43.2									
4.	*Quercus* sp.	25.9									
	Fagus silvatica	33.9	51.9	3.39	96.61	9.18	6.41	24.66	57.52	5.131	1 : 10.4
	Salix sp.	40.2									
5.	*Tilia cordata*	27.2									
	Corylus evellana	27.2	71.8	4.69	95.31	19.75	7.86	13.88	40.74	4.940	1 : 3.6
	Quercus sp.	45.6									
6.	*Quercus* sp.	41.1									
	Vaccinium myrtillus	15.6	72.4	7.79	92.21	16.03	3.62	14.78	57.78	4.590	1 : 5.0
	Salix sp.	22.9									
	Plantago maior	20.4									
7.	*Quercus* sp.	26.4									
	Vaccinium myrtillus	13.2	75.0	8.19	91.81	17.28	6.08	21.18	47.27	4.450	1 : 4.7
	Plantago maior	28.2									
	Rubus idaeus	32.2									
8.	*Quercus* sp.	21.6									
	Vaccinium myrtillus	11.6	76.1	8.19	91.81	17.28	6.08	21.18	47.27	4.417	1 : 4.7
	Plantago maior	32.0									
	Rubus idaeus	34.8									
9.	*Corylus avellana*	33.6									
	Quercus sp.	31.8	64.0	6.36	93.64	13.82	3.66	25.04	51.12	4.720	1 : 6.1
	Rubus idaeus	34,6									
10.	*Quercus* sp.	43.1									
	Rubus idaeus	34.6	58.4	7.25	92.75	9.93	4.34	20.18	53.59	4.616	1 : 8.9
	Corylus avellana	22.3									

* Calculated on the basis of really consumed plants constituting a given food.

Hitherto only few authors have studied this problem (Esser, 1958; Bubenik, 1959, 1959a; Lochman *et al.*, 1961; Juon, 1963). They carried out investigations on the food requirement by roe-deer, but the data on digestibility of natural feeds, essential for establishing the role of roe-deer in the energy flow and circulation of matter in an ecosystem, are still lacking. This gap is filled to a certain extent by the results of this preliminary study.

II. MATERIAL AND METHODS

The investigations were carried out on 3 individuals of roe-deer, *Capreolus capreolus* (Linnaeus, 1758), in the Kraków Zoological Garden. In the preliminary period of 7 to 10 days the animals stayed in an out-door enclosure 50 m^2 in area and were fed *ad libitum* with selected feeds. The length of this period enables with certainty for the food passage through the intestinal tract of roe-deer (Mautz & Petrides, 1971).

Natural diets were established on the basis of the results obtained by Siuda *et al.* (1969), but the selection of feeds supplied to the animals was limited to the plants occurring in the Wolski Wood near Kraków. In summer, spring and autumn the current growth of twigs with leaves was supplied, while in winter they were replaced with twigs not exceeding 3 mm in diameter, since such twigs are preferentially browsed by roe-deer in natural environment (Vaněk, 1958). In the proper experimental period (5 days) the animals were kept singly in a collection pen with wooden floor 6 m^2 in area. In that period they were given a definite amount of feeds, while faeces and not consumed residue were collected daily. Also representative samples of the supplied food were taken for the analysis. Water content was determined in them by drying at 105°C, caloric value by combusting in a calorimetric bomb KL-3, and moreover standard chemical analysis was carried out (A.O.A.C., 1960).

Food intake in the year cycle and coefficients of digestibility of dry matter and energy were determined in the experiments. The rectilinear regression was employed to describe a relationship between the obtained results.

III. RESULTS

1. Chemical Analyses of Feeds

The results of chemical analyses and caloric value of feeds are given in Table 1. Water content in the supplied feeds ranged from 44.9% in January to 76.1% in July. Autumn feeds contained approximately 60% of water.

The caloric value of feeds was the lowest in summer months and the highest in winter, while autumn feeds showed intermediate values (Table 1).

The most rich in protein was the diet in May experiment (19.7%), while the poorest — in winter (8.5% on average). The reciprocal rela-

Table 2

Intake and digestibility of natural foods within year cycle.

Item		No. of experiment								
		1	2	3	4		6	7	8	9	10
Month of exp.		Dec.	Jan.	Jan.	Mar.	May	July	July	July	Sept.	Oct.
Body weight		19.0	18.5	11.5	13.0	17.0	11.0	11.0	16.0	18.0	20.0
Food	fresh weight, g	682	697	579	760	2018	2235	2128	2401	1688	1378
intake	dry matter, g	372	385	266	355	565	555	478	521	596	574
	kcal	1809	1969	1316	1823	2791	2549	2126	2301	2813	2650
Crude protein $g/kg^{0.75}$		3.29	3.43	4.00	4.76	13.30	14.72	13.73	11.25	9.41	5.01
Faeces, dry weight, g		220	252	138	170	74	236	190	194	255	272
	kcal	1062	1342	684	837	356	1113	878	895	1149	1293
Digestibility coeff., dry matter, %		41.0	34.3	48.2	52.1	87.1	57.5	60.2	62.7	57.2	52.6
	energy, %	41.3	31.8	48.0	54.0	87.2	56.3	58.7	61.1	57.5	51.2
Digestible energy (*DE*) kcal		747	627	632	686	2435	1436	1248	1406	1619	1357
Kcal $DE/kg^{0.75}$		82	72	102	144	290	237	206	175	185	143

tionship was found for the fibre. This relative composition of food in respect of protein and fibre is reflected in the protein ratio. The broadest protein ratio was observed for winter feeds (mean 1:11), and the most narrow in May (1:3.6). The amount of ether extract ranged between 2.4 and 7.8% without any seasonal changes in the year cycle. In all diets a relatively stable level of nitrogen-free extract was found (around 50%). The amount of mineral substances varied between 3 and 7.5% (Table 1).

2. Digestibility

The digestibility of dry matter varied considerably during the year (Table 2). The highest digestibility was found in May and the lowest in winter experiments (Table 2). In summer the coefficient of digestibility

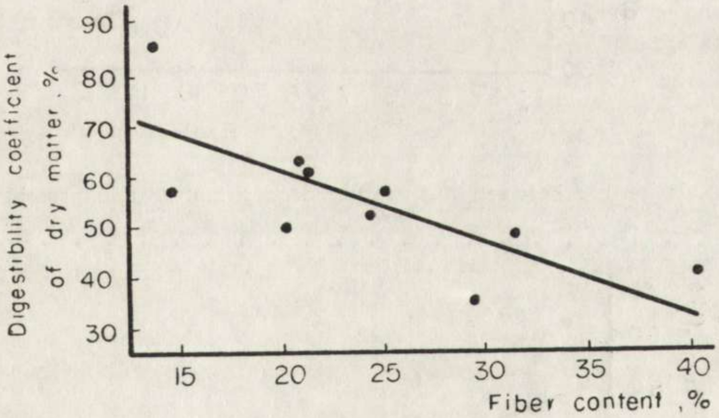

Fig. 1. Relationship between fibre contents in the feeds and digestibility of dry mater.

amounted to approximately 60%, while in autumn to 54%. This conspicuous variability of the digestibility coefficient is related to a different chemical composition of plants constituting the diet, mainly to fibre content.

The relationship between fibre contents in the feeds (X) and the coefficient of digestibility of dry matter (Y) is expressed by the following equation: $Y = 87.6 - 1.34X$ (Fig. 1). A still better correlation was found between the digestibility of the dry matter (Y) and protein ratio (X): $Y = 86.3 - 4.06X$ (Fig. 2), and between fibre content (X) and food intake (Y): $Y = 100.8 - 1.65X$ (Fig. 3).

3. Consumption

Roe-deer consumed from 580 g of biomass per day in Jannuary to 2,400 g in July (Table 2). The amount of consumed dry matter was the lowest in winter months — around 350 g, and the highest in September

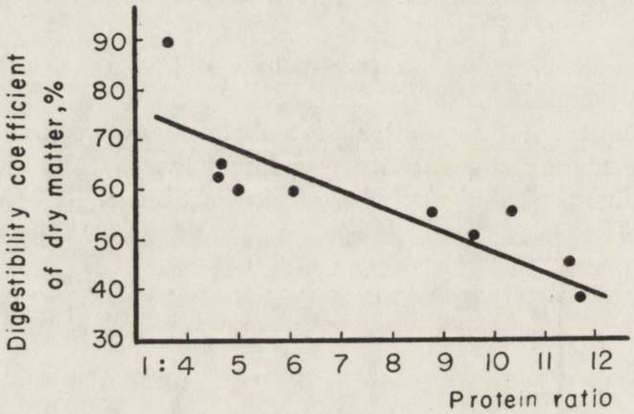

Fig. 2. Relationship between digestibility of dry matter and protein ratio.

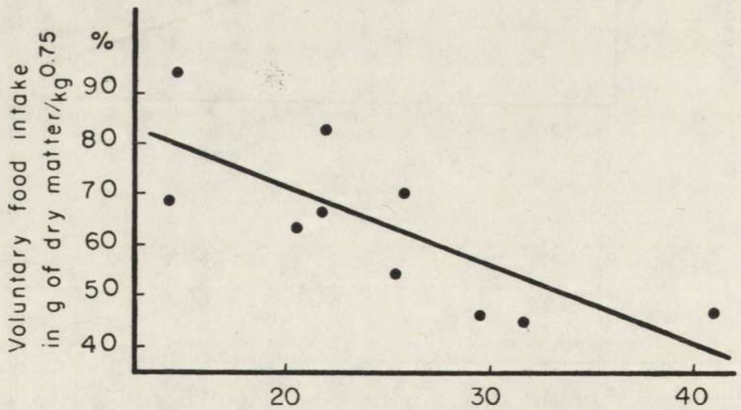

Fig. 3. Relationship between fibre content and food intake expressed in grams of dry matter/$kg^{0.75}$.

— 600 g per day. The mean intake of dry matter amounted in May and in summer to approximately 550 g d.m. per day (Table 2). The caloric value of the consumed food ranged from 1316 kcal per day in January to 2813 kcal in September (Table 2).

The amount of consumed feeds expressed in kcal of digestible energy (*DE*) was computed for the metabolic unit of body weight — in $kg^{0.75}$ (K l e i b e r, 1961). Consumption expressed in kcal $DE/kg^{0.75}$ ranged from 72 to 102 kcal $DE/kg^{0.75}$ per day in winter, while in May it reached 290 kcal $DE/kg^{0.75}$. For the whole year, except winter, this value amounted on the average to 197 ± 53 kcal $DE/kg^{0.75}$ per day.

IV. DISCUSSION

1. The Effect of Food Composition on Its Digestibility

The analyses of browse confirmed the data of S h o r t (1966) and D z i ę c i o ł o w s k i (1970) on a considerable variability in the chemical composition and caloric value of food available for deer in the year cycle. The digestibility of feeds is considerably affected by their chemical composition, and particularly by fibre content (H o g a n *et al.*, 1969; W e s- t o n & H o g a n, 1970) and protein level (H o g a n *et al.*, 1970). Very low coefficients of dry matter digestibility and energy of winter feeds arise from the low content of proteins and high content of fibre (Tables 1 and 2, Fig. 1). The browse of late spring and summer represents a valuable food for cervides since it contains more than 10% of total protein and relatively small amount of fibre (Table 1). A high correlation between the protein ratio and digestibility indicates the importance of protein level in roe-deer food, while broadening of the protein ratio leads to a conspicuous decrease in the digestibility (Fig. 2).

2. Food Intake and Costs of Maintenance

Food consumption by the cervides changes considerably during the year. Particularly large variations were observed between the winter and the remaining seasons. This phenomenon has been repeatedly observed in the deer (L o c h m a n *et al.*, 1961; W o o d *et al.*, 1962; B a n- d y *et al.*, 1970; N o r d a n *et al.*, 1970). Decreased food consumption in winter, or complete fasting of a male during the rut period, is accompanied by the loss of body weight which may reach in some cases 35% of the maximum body weight in a given year (N o r d a n & C o w a n, 1968).

The decreased food intake by the studied roe-deer was caused also by a high content of fibre in the browse constituting the only food in winter. Van S o e s t (1965) claims that the volume occupied by a slowly digested fraction becomes large in relation of the digestive tract volume, limiting further intake. Hence it appears that the effect of fibre content on the digestibility (Fig. 1), and in consequence of food consumption, is clear (Fig. 3).

Relatively low protein content in winter browse (Table 1) also affects the food intake. The deer prefers feed of high protein and fibre contents in comparison with feeds poor in these constituents (Nagy *et al.*, 1969). High protein contents certainly enable better utilization of food (Fig. 2), although at low level of proteins the ruminants can maintain a constant level of nitrogen in the rumen by utilizing the endogenous nitrogen (Klein & Schönheyden, 1970).

The intake of digestible energy per day in winter was found to be around 72—102 kcal/kg$^{0.75}$, *i.e.* approximately two times less than in summer and autumn. Even taking into consideration the fact that the basal metabolism of deer is in winter lower by 50 to 70% (Silver *et al.*, 1969, 1971) the observed energy intake seems to be inadequate. The supplied food in this period consisted of tree twigs only, hence it corresponded to feeds available at extremely difficult winter conditions with a thick snow cover. At a small amount of snow roe-deer have access to more easily digested herb layer plants. Lochman *et al.* (1959) and Siuda *et al.* (1969) determined that the browse from trees and shrubs constitutes for roe-deer in winter up to 60—80% of total feeds.

However, taking into consideration these extremely difficult winter conditions, and assuming that the roe-deer requires daily 120 to 140 kcal *DE*/kg$^{0.75}$. Ullrey *et al.* (1969, 1970) reported the value of 158—160 kcal/kg$^{0.75}$ for pregnant does of *Odocoileus virginianus*, then the daily deficit for an animal weighing 18 to 20 kg would amount to 40 to 50 kcal/kg$^{0.75}$, *i.e.* around 400 kilocalories. To cover this deficit the animal should utilize approximately 50 g of body fat daily. From the investigations on the composition of the roe-deer carcass it appears that these animals may have 1.5 kg of fat, which can be utilized to cover energy deficit in extremely difficult winter conditions (Weiner, unpubl. data). The fat reserves enable roe-deer survive for approximately one month in extremely unfavourable winter conditions.

Nitrogen is equally important factor in seasonal feeding of roe-deer. In winter months, when the content of total protein ranged from 8 to 9%, the animals consumed 3.43 to 4.76 g/kg$^{0.75}$ of this constituent (Table 2). Such amount is sufficient for a pregnant sheep to maintain positive nitrogen balance and normal body weight gain during pregnancy (Robinson *et al.*, 1970). Summer feeds cover totally the requirements of roe-deer for nitrogen. On the natural browse containing 13 to 19% of protein (Table 1) the protein intake amounted to 11.2—14.7 g/kg$^{0.75}$. In the experiments of Lochman *et al.* (1961) the animals consumed in winter 8.5, in spring 7.1 and in autumn 15.8 g of protein/kg$^{0.75}$. These results were obtained by feeding the animals with an unnatural food.

As appears from the considerations presented above the winter is a critical period for roe-deer when they are lacking easibly digestible and rich in proteins feeds. They can survive this period due to: improved insulatory properties of the fur, reduced metabolism and activity, as well as ability to utilize less valuable feeds to maintain the balance of energy and nitrogen.

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KONSUMPCJA I STRAWNOŚĆ NATURALNYCH POKARMÓW U SARN

Streszczenie

Na trzech sarnach *Capreolus capreolus* (Linnaeus, 1758) wykonano metodą bilansową doświadczenia nad pobraniem i strawnością naturalnych pokarmów w cyklu rocznym. Analizy chemiczne wykazały wyraźną zmienność składu chemicznego w zależności od sezonu (Tabela 1). Najwyższą zawartość białka ogólnego stwierdzono w pędach wiosennych i letnich (16—19%), natomiast najniższą w zimowych (8—9%). Zawartość włókna była najwyższa w paszach zimowych (30—47%) (Tabela 1).

Konsumpcja również zależała od sezonu i wahała się od około 350 g s.m. w zimie do około 600 g s.m. w lecie tj. od 1300 do 2800 kcal/dobę. Strawność suchej masy zależała od pory roku i składu chemicznego paszy. Najwyższy współczynnik strawności suchej masy stwierdzono w maju (87%) a najniższy w styczniu (34%) (Tabela 2). Stwierdzono wyraźną zależność między zawartością włókna a strawnością (Fig. 1), stosunkiem białkowym a strawnością (Fig. 2) oraz zawartością włókna a pobraniem paszy (Fig. 3).

Pobranie energii strawnej przez sarny w zimie wahało się od 70 do 102 kcal/kg$^{0.75}$ doba, natomiast średnie pobranie dla pozostałych sezonów wynosiło 197 ± 53 kcal/ /kg$^{0.75}$ doba.